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INTERNATIONAL COOPERATION AND NUCLEAR REACTOR PROJECT DEVELOPMENT

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The time between the 1st and the 2nd U.N. Conferences on the Peaceful Uses of Atomic Energy has witnessed considerable progress in the utilization of atomic energy for the benefit of mankind. The achievements of the vigorously developing nuclear science and engineering, the ever greater mastery of the atomic energy and its introduction in almost all branches of science and economy in highly developed countries have enabled practical utilization of this energy in countries which are yet making their first steps on the path of the scientific and economic development, have strengthened and extended cooperation in this important field.

During six years which passed after the 2nd U.N. Conference our country has steadily endeavoured to promote, as far as possible, the international cooperation and establish contacts between scientists in the peaceful uses of nuclear energy.

MUTUAL VISITS

The research institutes of the USSR which study major problems of nuclear physics and engineering have been lately visited by the leading atomic industrialists and outstanding scientists from a number of countries. Under the concluded agreements the Soviet scientific delegations made mutual visits to the socialist countries, the United States of America, Italy, France and Denmark.

Close contacts were maintained with the scientists of the socialist countries: the Soviet scientific and research centres which have nuclear reactors, accelerators and nuclear plants were visited by leading administrators, scientists and engineers from Czechoslovakia, Rumania, Hungary, German Democratic Republic, Poland, Bulgaria, and others. These visits contributed to further promotion and expansion of scientific ties between the Soviet scientists and the scientists of these countries.

Among those who visited the Soviet Union were: Supreme Commissioner for the Atomic Energy with a group of experts (France), Chairman of the Atomic Energy Authority (Great Britain), Chairman of the U.S. Atomic Energy Commission with a group of scientists (in 1959 and 1963), a delegation of the Atomic Energy Commission of Canada, Chairman of the Atomic Energy Com-

mission (Finland), Chairman of the Atomic Energy Commission (Denmark), Chairman of the Atomic Energy Commission (Afghanistan), Deputy Chairman of the Atomic Energy Commission with a group of scientists (Ghana), and others.

In 1959 a group of Soviet Scientists led by Chairman of the State Committee for the Utilization of Atomic Energy of the USSR visited the United States and France. In 1960 a delegation of Soviet scientists visited Britain. In 1962 a Soviet delegation led by a Deputy Chairman of the State Commission for the Utilization of Atomic Energy of the U.S.S.R. made a return visit to Sweden, and, in 1963, to Canada. In 1962 a delegation headed by a Deputy Chairman of the State Committee went to Britain to discuss various problems of the reactor physics and fast reactors.

In 1963 a delegation of Soviet atomic scientists led by the Chairman of the State Committee for the Utilization of Atomic Energy of the U.S.S.R. visited the USA and Poland.

The Soviet Union also exchanged scientists with other countries; these scientists worked in the research centres of a number of countries for periods of time up to one year.

EXCHANGE OF SCIENTIFIC AND TECHNICAL INFORMATION

Considering that the expansion of scientific contacts and dissemination of scientific and technical information are of great importance the Soviet Union publishes annually up to 4000 articles on atomic subjects in technical journals of a general nature and in specialized journals. The U.S.S.R. has a special publishing house "Atomizdat" dealing exclusively with books on atomic subjects which maintains a wide-scale book exchange with other countries.

Everybody knows that it was the U.S.S.R. which took the initiative in unclassifying the information on thermonuclear research. Restrictions on open publication of such information were removed in various countries of the world only after 1956 when Academician Kurchatov made a detailed report to British colleagues in Harwell about the work being carried out by the Soviet scientists in this field. On the occasion of the 2nd U.N. Conference which took place in Geneva in 1958, the Soviet Union published a four-volume collection of works and also submitted papers on thermonuclear research carried out in the U.S.S.R.

The proceedings of the Geneva Conferences which represent a major contribution to international cooperation are regularly published in the U.S.S.R. and enjoy well-deserved popularity.

Apart from personal contacts the Soviet Union maintains a wide-scale exchange of scientific information with socialist countries. Similar exchange of scientific and technical information was organized with the USA, Britain, France and other countries under bilateral agreements.

In addition to what has been said above, during the time considered here the Soviet scientists and experts took a most active part in international and national conferences, symposiums and meetings; they submitted papers, delivered lectures and participated in various discussions, thereby promoting and expanding scientific ties and international cooperation with the scientists of various countries.

Tremendous work is being done by the State Committee for the Utilization of Atomic Energy of the U.S.S.R. to popularize the ideas of the peaceful uses of atomic energy by displaying scientific and technical exhibitions which illustrate the benefits offered to mankind by atomic

energy. These exhibitions were displayed many times both in the U.S.S.R. and in 39 countries of Europe, Asia, Africa and South America as well as in the USA. More than 22 million of people came to see the Soviet exhibitions.

BILATERAL AGREEMENTS AT GOVERNMENTAL LEVEL

Beginning from 1955 the U.S.S.R. has rendered and is still rendering scientific, material and technical aid to other countries both in the research work and in the delivery of equipment and technical information. Since 1955 the Soviet Union has concluded 30 bilateral agreements and protocols on the governmental level with 15 countries: People's Republic of Bulgaria, Polish People's Republic, German Democratic Republic, Rumanian People's Republic, Socialist Republic of Czechoslovakia, Chinese People's Republic, Korean People's Democratic Republic, Federal People's Republic of Yugoslavia, United Arab Republic, Iraq Republic, Republic of Indonesia, Republic of Ghana, Republic of India and Afghanistan.

In these agreements the U.S.S.R. undertakes the following commitments:

to render technical aid in construction of research reactors, accelerators, radiochemical, isotopic and physical laboratories which are to grow into national atomic research centres;

to train national personnel in operation of atomic installations and in carrying out nuclear research;

to render technical assistance in building research, experimental and power reactors;

to carry out joint investigation of various scientific problems and development of instruments, facilities and shielding;

to organize joint consideration and discussion of the plans for scientific and research work in peaceful uses of atomic energy;

to exchange practical experience in the production of radioactive isotopes and sources and the methods of their employment.

The following equipment for the research centres being organized in other countries with the help of the U.S.S.R. was developed and designed by the Soviet scientific, design and projecting agencies: five types of research reactors – a heavy-water reactor (TVR), a water-cooled and water-moderated reactor (VVR), a swimming-pool reactor (IRT), a 100-kw reactor and a 50-kw reactor for training and research; a 25-Mev accelerator of elementary particles with a physical laboratory; an electrostatic generator; a radiochemical (isotopic) laboratory; sub-critical assembly for training purposes; a 30-Mev betatron; a powerful radiocobalt installation.

The Soviet Union has delivered large amounts of complex unique equipment, apparatus and special materials for building atomic installations in these countries. It is a characteristic fact that the Soviet Union makes these deliveries on the basis of usual trade agreements without stipulating any political, economic or other conditions. This fully applies to the deliveries of fissionable materials for research purposes and to the deliveries of fuel elements for research reactors.

More than 700 highly qualified Soviet experts were sent to the countries mentioned above to help in construction, assembling, adjustment and commissioning of the delivered equipment.

Since 1957 the Soviet Union has rendered assistance in construction and commissioning

of 9 nuclear reactors, 6 cyclotrons, 7 radiochemical and physical laboratories, one electrostatic generator and a sub-critical assembly which form the basis for national atomic research centres in Rumania, Czechoslovakia, Poland, Hungary, Bulgaria, the German Democratic Republic, Chinese People's Republic, Yugoslavia and U.A.R. The scientists and experts of these countries have started wide-scale scientific and experimental investigations in the field of atomic energy.

Atomic research centres are also being set up in the Korean People's Democratic Republic, Iraq, Indonesia, Ghana and Afghanistan where 13 atomic installations are to be built, including reactors, radiochemical and physical laboratories, accelerators, a powerful radiocobalt installation, a sub-critical assembly and various auxiliary structures.

Using the working projects received from Soviet projecting agencies these countries are now building atomic research centres. Research reactors are scheduled for commissioning in these centres within the following time periods: in Iraq, the Korean People's Democratic Republic and Ghana – in 1965, in Indonesia – in 1966.

Radio-chemical isotopic laboratories are to be built:

in Iraq and in the Korean People's Democratic Republic – in 1965,

in Ghana – in 1966.

Various auxiliary buildings and structures are being erected in these centres under the projects received from the U.S.S.R., including radioactive waste burial and decontamination stations, special laundries. disinfection stations.

In September 1963 the U.S.S.R. and Afghanistan signed an agreement on cooperation which provided for the rendering of technical assistance in the construction of a sub-critical assembly, in the organization of a physical laboratory, and in the training of Afghan specialists for work in the peaceful uses of atomic energy. The building of a sub-critical assembly is to begin in 1964 and the assembly will be finished within the first half of 1965.

New agreements which have been concluded over the recent years with a number of countries provide not only for the rendering of technical aid in the design and construction of nuclear plants and installations but, first and foremost, for cooperation through the joint work in solving a broad variety of scientific problems involved in peaceful uses of atomic energy. Such agreements were concluded with the Hungarian People's Republic, the Socialist Republic of Czechoslovakia, the Federal Socialist Republic of Yugoslavia, the Rumanian People's Republic, the German Democratic Republic, and the Polish People's Republic.

Under the new agreements cooperation with the socialist countries is effected by performing joint research, by training the national personnel in accordance with the mutually agreed curriculae and syllabuses, by sending Soviet experts to these countries to act as advisors, carry out joint investigation of separate scientific problems and develop experimental facilities, by sending specialists from these countries to the USSR for consultations, by handing over technical documentation by the Soviet side, by delivering equipment and offering expert opinion on various projects.

The Soviet scientists and the scientists of socialist countries attend joint meetings and conferences where they exchange the experience in the operation of research reactors and the

results of the work carried out on such reactors, consider and coordinate the plans of scientific research and discuss various urgent scientific problems.

The Soviet scientists and experts took part in the discussion of the plans for the development of nuclear science and engineering in the German Democratic Republic, Czechoslovakia, Poland, Hungary and Rumania. They examined the projects for construction of new nuclear reactors and sub-critical assemblies in these countries and gave advice on these projects.

For example, using advice of the Soviet scientists and experts the Polish scientists and experts are engaged in the preparation for remodelling the operating reactor VVR-S, which is to be effected in two stages. At the first stage the work will be participated in by the Czechoslovak experts: at this stage scheduled to end in 1964 the reactor capacity is to be raised to 4000-4500kw by increasing the velocity of the coolant circulating through the core, as it has been done in modifying the Soviet reactor VVR-2.

The second stage of modification is planned to be carried out on the basis of the scheme developed by Czechoslovak experts. The scheme provides for complete remodelling of the core and utilizing new circular fuel elements with 36%-enriched uranium-235 developed for the reactor VVR-M. At this stage planned for 1966 the reactor capacity will be brought up to 10.000 kw by increasing the neutron flux density. Naturally the second stage of the reactor VVR-C modification will necessitate considerable additions to, and modifications of, technological equipment. New fuel elements will be delivered by the Soviet Union.

Czechoslovakia, Hungary and Rumania have worked out the projects for modernization of their operating reactors VVR. Modernization is to be carried out jointly by the Soviet, Czechoslovak, Hungarian and Rumanian experts.

In accordance with the request of the U.A.R. Atomic Energy Commission the Arab and Soviet scientists have been carrying out joint research on a nuclear reactor and on other equipment in the Cairo atomic research centre.

The results of a number of interesting scientific investigations performed jointly by the Soviet and Arab experts in the atomic centre were published in the Arab, Soviet and foreign scientific journals.

At present the Cairo Atomic Research Centre has an efficient scientific staff consisting mainly of young physicists. The Soviet scientists have given here more than 300 lectures on various problems of physics. Practical seminars are regularly held on radio electronics and radio chemistry of isotopes.

The Soviet Union has delivered to the U.A.R. a large amount of equipment, apparatus, special and fissionable materials to be used for scientific and experimental research.

INTERNATIONAL COOPERATION IN JOINT INSTITUTE OF NUCLEAR RESEARCH

A vivid example of cooperation between the socialist countries is the setting-up of an international organization – the Joint Institute of Nuclear Research in the town of Dubna. As far back as in 1956 two unique accelerators were given as a gift to this research centre by the Soviet Government: a synchrocyclotron for 680 Mev and a synchrophasotron for 10 Gev. Since that time the efficient international staff of the institute has built new nuclear installations: a pulsed fast

reactor, a multiply charged ion cyclotron. New laboratories, mechanical workshops and other structures have been built. At present several hundreds of scientists who came to Dubna from the member countries of the Institute work at this Institute together with the Soviet scientists. Publications of the Joint Institute of Nuclear Research are sent to all large scientific centres in Europe, Asia, Africa, USA and Latin America.

Important investigations on research reactors are performed in the member countries of the Joint Institute. In this connection a suggestion has been made to plan such investigations, rationally select the lines of research and coordinate the joint scientific investigations. Further extention of scientific cooperation between the member countries of the Joint Insitute of Nuclear Research was marked by the setting-up of a division for nuclear physics of low energies within the Scientific Council of the Institute. This division is called upon to submit scientific recommendations on various problems of nuclear physics of low energies, to examine the plans for, and the reports on, the joint research, to organize exchange of information on scientific and methodological investigations by holding conferences, meetings, etc.

Several conferences and meetings were held on the problems of research reactor physics and engineering.

In 1960 a conference on the operation and use of research reactors was held in the Central Insitute of Nuclear Physics in Dresden, GDR. This conference was attended by about 150 scientists and engineers from nine countries. The delegates worked in various sections where they discussed the experience accumulated by the member countries in the operation of research reactors, expansion of their experimental potentialities and use of reactors for scientific research. The sections of nuclear physics and solid-state physics discussed the results of first investigations which were performed on these reactors. The conference pointed out a number of scientific and engineering problems which had to be solved in the nearest future; specific countries were named which might, on the basis of their experience and specialization, undertake the solution of separate problems.

In November 1961 a conference on research reactor physics and engineering was held in Bucharest (RPR), which was attended by 80 delegates from 9 countries. Sixty-eight papers were submitted on the following main problems:

1. Experience of research reactor operation, their use and expansion of their experimental potentialities.

2. Theoretical and experimental reactor physics and engineering:

(a) thermalisation of neutrons;

(b) further development and application of reactor oscillator method for measuring neutron capture cross-sections by various materials and studying the kinetic parameters of reactors;

(c) application of pulsating neutron sources for studying physical parameters of moderators;

(d) application of neutron flux fluctuation analysis for studying dynamic characteristics of lattices;

(e) study of reactor transient behaviour;

(f) investigation of spatial distribution of neutron spectrum and gamma-radiation;

3. Development, construction,use of zero-power sub-critical and critical assemblies and reactors.

4. Theoretical and experimental problems involved in the measurement technique of neutron fluxes and gamma fields.

The papers were discussed at plenary sessions and in various sections and groups. The meeting adopted recommendations on the improvement of reactor cores and experimental channels; on designing auxiliary devices to expand experimental potentialities for scientific and applied research; on the construction and application of critical assemblies to avoid the use of reactors for low-power work; on increasing the capacity of reactors VVR-S and on lines of investigations on research reactors.

The next meeting on reactor physics and engineering took place in Prague (Czechoslovakia) in April 1963, which was attended by 89 delegates from 9 countries. The delegates worked in two sections (engineering and physical). The following problems were discussed:

The engineering section:

(a) experience of research reactor operation;

(b) improvement of technological schemes, reactor control and monitoring systems;

(c) reactor loops;

(d) construction and control systems of critical assemblies;

(e) radiation shielding.

The physical section:

(a) reactor theory;

(b) critical experiments;

(c) increasing of power of the operating research reactors;

(d) reactor oscillators, measurement of constants and neutron fluxes;

(e) physical experiments on neutron beams;

(f) neutron spectra.

115 papers were submitted to the meeting; six papers discussed at the plenary sessions dealt with the problems of increasing the power of reactors VVR-S and IRT, experience of operation of reactor VVR-M, investigation of characteristics of pulsed reactor IBR.

Many papers were devoted to the development of critical assemblies and to certain experimental results obtained on these assemblies, to the problems of reactor control and shielding and to reactor theory.

Some papers dealt with the operating loops in research reactors.

The meeting has worked out recommendations on the cooperation in the field of reactor engineering.

The conferences and meetings are not confined to the discussion of the work done in the past but also examine the plans for the future including joint investigations, problems of mutual cooperation in designing and manufacturing unique apparatus.

Today the reactor research centres set up with the assistance of the USSR in the socialist countries have become full-fledged scientific organizations which are making a major contribution to the world science and meet the needs of the national economy of their countries.

INTERNATIONAL COOPERATION IN THE FIELD OF NUCLEAR POWER

Technical and economic aspects of nuclear power development have great importance for all socialist countries and therefore the prospects of this branch of power engineering attracts considerable attention. A special meeting of scientists and experts from the socialist countries was held to discuss a number of problems involved in further development of nuclear power.

Nuclear power generation requires a thorough scientific advance planning.

Its development must be tied in with the strengthening of scientific and technological basis, with setting-up of specialized projecting-designing agencies, with participation of machinebuilding works in the manufacture of necessary equipment and with the solution of problems involved in reprocessing of nuclear fuel and with the solution of an important problem of radioactive wastes disposal.

Unfortunately, it is rather difficult, at this stage, to determine with sufficient accuracy, the comparative economical indices of nuclear power stations due to the lack of experience in extensive industrial use of such stations. A possible approach to the solution of this problem is the development, construction and thorough analysis of operation of experimental-industrial nuclear power stations of various types.

The planned nature of the socialist economy enables to make a complex analysis, rather than to analize each station separately, taking due consideration of possible and necessary rates of nuclear power development and development of all associated branches of industry, including the fuel factories and the works manufacturing reactor equipment.

This analysis will make it possible to find the cost of one kilowatt of installed capacity and the cost of one kilowatt-hour of electric power for a nuclear power station and to make a general technical and economic analysis of all branches of economy associated with nuclear power development.

The Soviet Union renders technical assistance to Czechoslovakia and GDR in building nuclear power stations having the following capacities: in Czechoslovakia – a 150-megawatt reactor plant with a vessel-type reactor using natural uranium, heavy water and gas coolant in GDR, a 70-megawatt reactor plant using enriched uranium and light water as a moderator and coolant.

The Soviet, Czechoslovak and German experts cooperate in solving complex technical problems involved in the designing, construction and manufacturing of the equipment for these nuclear power stations. They carry joint experimental and scientific investigations on a large variety of problems, seek the solution of technical problems involved in the construction of these nuclear power stations.

Construction of nuclear power stations in the USSR, Czechoslovakia and in the German Democratic Republic – will make it possible, after sufficient operational experience had been accumulated, to select the best type of reactors, both in the technical and economic respect, which would be more reliable and competitive than other types of power plants generating electric energy.

COOPERATION IN PERSONNEL TRAINING

The USSR is rendering a great help in training national personnel. As of January 1, 1964, the Soviet Union has trained 1680 foreign specialists, including:

Operating personnel for reactors and cyclotrons, research physicists and radiochemists – 930.

Specialists in uses of radioactive isotopes and radiations:

in industry – 370

in medicine, biology and agriculture – 380

Training is carried out under a specially prepared curriculum published in Russian and in English.

INTERNATIONAL COOPERATION IN IAEA

The Soviet Union takes an active part in the work of the International Atomic Energy Agency and in the IAEA-sponsored conferences, symposia, seminars and meetings on various problems of atomic science and engineering and on various aspects of their development.

Thus, in 1960, the Soviet scientists and engineers took part in the conference on small and medium-power reactors and in a symposium on the physical research carried out with the help of reactor neutrons.

The Soviet experts participated in the meeting on the drafting of regulations for safe operation of critical assemblies and research reactors, which adopted a guide for operation of such installations, as well as in the meeting on the liabilities for atomic-powered ships which took first steps in working out of a corresponding convention.

In 1961 nine Soviet delegates took part in the symposia which framed the programmes for the utilization of research reactors and discussed the problems of experimental power reactors, as well as in a seminar on the physics of fast and intermediate reactors. The Soviet delegates submitted 19 papers.

A delegation from the Soviet Union took an active part in, and submitted two papers to, a symposium on reactor safety and methods of danger evaluation, which was held in Vienna in 1962. In the same year a Soviet delegate to the meeting on drafting a long-term plan of nuclear power development submitted a number of proposals which helped the IAEA to work out a detailed plan of work in this field.

In 1963 the USSR took part in all discussions on reactor development and operation sponsored by the Agency.

Scientists and experts represented the USSR at the conferences on the operation of power reactors and on the technology of new nuclear materials including non-metal fuel elements, at symposia on exponential and critical experiments, on the physical problems and selection of materials for reactor control rods. The Soviet delegates participating in these meetings submitted 20 papers.

The Soviet experts exchanged opinions and experience with their foreign colleagues at the meetings on heavy-water lattices, on chemical investigations carried out with the help of research reactors, on working out safeguards for reactors with a capacity above 100 MW, on

economic problems connected with inclusion of nuclear power stations into the power grids. They also took part in a seminar for administrative personnel working in the field of atomic energy.

COOPERATION AND PEACEFUL POLICY OF THE USSR

True to the Lenin's principles of foreign policy – the policy of peace, friendship and extensive cooperation with all countries the Soviet Union has accumulated much experience in peaceful uses of atomic energy in all branches of national economy, has always promoted and is promoting expansion of international cooperation in this field.

Pursuing the policy of peace, the Soviet government, the Soviet people and the peoples of the socialist countries as well as all peoples of the world whole-heartedly and with much satisfaction welcomed the signing of the Moscow Treaty on the ban of nuclear testing in atmosphere, space and under water as the first step towards the successful solution of the problem of general and complete disarmament. Everybody understands how dangerous is the contamination of our planet by the products of nuclear explosions. That is why the Soviet people are proud of the fact that it was in Moscow that the Treaty was signed which marks the beginning of putting an end to radioactive contamination of our planet.

The harnessing of atom, this supreme achievement of human genius, must be used for the benefit and only for the benefit of mankind; atomic energy, this powerful means of scientific and technical progress, must be used only for peaceful purposes.